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NATIONAL DAM SAFETY PROGRAM. ALLOWAY LAKE DAM (NJ00038), DELAWA--ETC(U)
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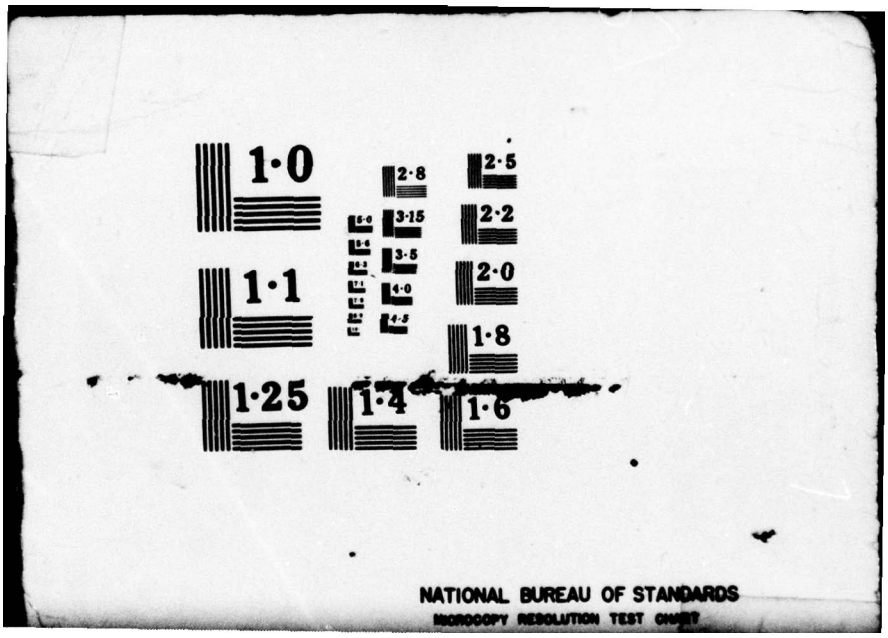
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DELAWARE RIVER BASIN
ALLOWAY CREEK, SALEM COUNTY
NEW JERSEY

LEVEL II

ALLOWAY LAKE DAM

NJ 00038

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Approved for public release;
distribution unlimited

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

March, 1979

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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Safety
Visual inspection
National Dam Inspection Act Report
Alloway Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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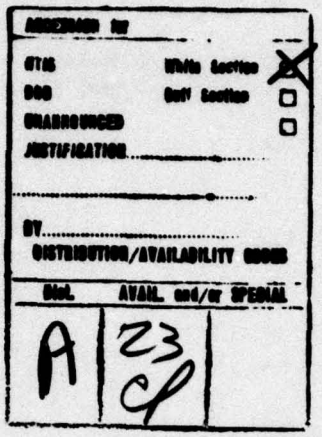

15 MAY 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Alloway Lake Dam in Salem County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Alloway Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 32 percent of the Probable Maximum Flood--(PMF) - would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage. Any remedial measures found necessary should be initiated within calendar year 1980.

c. The following remedial action should be completed within three months from the date of approval of this report.

(1) The downstream channel immediately below the main spillway should be filled with riprap to prevent further undercutting of the concrete spillway apron. Consideration could be given to driving additional sheeting parallel and downstream of the spillway wingwalls and backfilling behind the added sheeting.

(2) The undercut apron slab at the auxiliary gate outlet should be backfilled and channel protection dumped in the stream bed.

(3) The dam crest should be regraded and brought up to a uniform elevation and the major swales cut into the backslope filled and regraded.

d. The following remedial actions should be completed within one year from the date of approval of this report:

(1) Trees should be removed and the dam backslope regraded and protected.

(2) A checklist for periodic maintenance inspections should be developed so a record of conditions and repairs can be maintained.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman William J. Hughes of the Second District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation

of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
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Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
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Trenton, NJ 08625

ALLOWAY LAKE DAM (NJ00038)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 10 January 1979 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Alloway Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 32 percent of the Probable Maximum Flood--(PMF) - would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

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APPROVED: _____

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 11 May 1979

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Alloway Lake Dam Fed ID# NJ 00038 and NJ ID# 455

State Located New Jersey
County Located Salem
Coordinates Lat. 3933.9 - Long. 7521.7
Stream Alloway Creek
Date of Inspection 10 January 1979

ASSESSMENT OF GENERAL CONDITIONS

Alloway Lake Dam is assessed to be in a generally fair overall condition but refilling of the downstream stilling basin below the spillway should be undertaken very soon to preclude a collapse of the lower portion of the spillway apron. Sufficient engineering data was not available to ascertain the continued long-term stability of the embankment as three previous breachings have completely washed out wide zones of embankment and further engineering studies are recommended to be undertaken in the near future. Recommended remedial actions also to be undertaken very soon include protecting the auxiliary spillway outlet channel, regrading the dam crest and repairing the natural drainage swales on the embankment backslopes.

The main spillway and auxiliary sluice gate can accommodate only 31% of the probable maximum flood.

F. Keith Jolls P.E.
Project Manager

OVERVIEW OF ALLOWAY LAKE DAM

JANUARY 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: ALLOWAY LAKE DAM FED ID# NJ 00038

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Alloway Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Alloway Lake Dam is a 700 foot long straight earth embankment structure with a top width of 14 feet. An 80 foot wide concrete spillway is located 125 feet from the right (northerly) abutment. There is a 48-inch sluice gate and cast iron pipe outlet located at a gaging station at the right abutment and evidence elsewhere of two older spillway outlets which have long been demolished and filled in with reconstructed embankment. The dam forms the entire westerly edge of Alloway Lake.

b. Location

Alloway Lake Dam is located approximately 1200' east of Greenwich Street (County Road 540) in Alloway, Alloway Township, Salem County and is 1,500 feet north of the intersection of Greenwich Street and County Road 581.

c. Size Classification

The maximum structural height of the dam is 20 feet at the spillway and the maximum storage is estimated to be 1,340 acre-feet. Therefore, the dam is placed in the intermediate size category as defined by the Recommended Guidelines for Safety Inspection of Dams (storage greater than 1,000; less than 50,000 acre-feet).

d. Hazard Classification

Based upon the Corps of Engineers criteria and as a result of the field inspection of downstream conditions, the dam is recommended to be downgraded from a high hazard to a significant hazard classification. Failure would cause some hazard increase to downstream residents but there is only one house within the immediate downstream flood plain. However, the old concrete bridge approximately 1,000 feet downstream on Greenwich Street has a somewhat limited hydraulic capacity and there would be appreciable economic loss should this bridge be damaged or destroyed.

e. Ownership

The most recent records of the N.J.D.E.P. Division of Water Resources indicate that the dam and a part of the lake were owned by McEldowney & Company, Main Street, Alloway. However, local residents informed the inspection team that Mr. William Luria (address unknown) now has title to the dam and a portion of the lake property nearby the dam and Mr. John Zule (address unknown) has title to the upper portion of the lake bottom.

f. Purpose of Dam

The dam presently impounds a privately owned pleasure and recreation lake.

g. Design and Construction History

The present concrete spillway was constructed in 1933, replacing an existing timber structure that was located approximately 250 feet to the south. It is unknown when the dam or spillway was originally constructed. However, judging from the size of the trees on the embankment, the dam is thought to be well over 100 years old and originally impounded a mill pond for the Ewen Milling Company. The 1933 plans indicate the presence of a mill raceway near the left abutment but it has been substantially filled in and little could be observed of its exact configuration. In September 1950 the dam failed near the right abutment, washing out a portion of the earth embankment but leaving the concrete spillway intact. Steel sheeting was installed to replace the existing timber sheeting at the toe of the spillway in 1952 because of the extremely poor condition of the timber. Additional concrete was poured at the toe to fill in the gap between the new sheeting and the spillway apron. A 48" Armco slide gate sluiceway was also added at this time along with the staff gage (both at the right abutment where the breaching occured). In 1961, the Bureau of Water Control requested that the banks be cleared of all trees; however the Phase I inspection revealed that little or no deforestation was undertaken. There is hearsay information that the dam was also breached in 1940 and repaired. The exact nature of what transpired is unknown.

h. Normal Operating Procedures

There is no evidence that there are any operations conducted at Alloway Dam except the sporadic opening of the 48 inch sluice gate during periods of heavy flow (see Section 4).

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Alloway Lake Dam is 21.9 square miles.

b. Discharge of Dam Site

The spillway capacity with the reservoir at the abutment top elevation is calculated to be approximately 3,040 cfs. No discharge records are available at this site although a gaging station is reportedly in operation at the right abutment.

c. Elevation (Above M.S.L.)

Recreation Pool - 14.40
Top of dam - 20.0
Streambed at Center Line of Dam - at main sea level

d. Reservoir

Length of Recreation Pool - 1,500 feet.
Length of Maximum Pool - 9,200 feet

e. Storage

Recreation Pool - 490 acre-ft.
Top of dam - 1340 acre-ft.

f. Reservoir Surface

Recreation pool - 107.6 acres
Top of dam - 225 acres

g. Dam

Type - Earth embankment with concrete spillway
Length - 700 feet
Structural height - 20 feet
Hydraulic height - 14.4 feet
Freeboard between normal reservoir and top of dam - 5.6 feet
Top width - 14+ feet
Side slopes - 2H:1V
Zoning - composition and compactness unknown

h. Diversion and Regulating Tunnel

None

i. Spillway

Type - Concrete, shallow vee-notched weir
Length of weir - 80 feet
Crest Elevation - +14.40 at centerline
(0.5' rise to corners - see plate)

j. Regulating Outlets

48" vertical lift sluice gate (inlet invert elevation +5.0)

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design plans were available for the 1933 concrete spillway construction which were prepared by H.B. Keasly, N.J.P.E. #82. Additionally, the embankment and timber sheeting cut-off details were located which indicated the 1933 removal of an existing timber spillway located about 250 feet south of the present spillway. Further, sketch application plans were available from the N.J.D.E.P. for the 1952 installation of the 48-inch sluice gate. No design analyses or records of any subsurface investigations were located. The predominant soils in the vicinity are composed of recent alluvium sands and silts with discontinuous intermingled layers of clay. The alluvium overlies swampy deposits in many areas which are generally encountered at depths less than ten feet. Drainage of the foundation soils is usually poor. The depth to bedrock is greater than 100 feet.

2.2 CONSTRUCTION

No data was disclosed regarding who accomplished the earlier construction or what records were kept. As the dam has always been in private ownership, it is doubtful if any records are readily available.

2.3 OPERATION

The dam has operated as a simple overflow facility with very infrequent regulation of the lake level by use of the 48-inch sluice gate. (See Section 4).

2.4 EVALUATION

a. Availability

Sufficient engineering data is available to determine the structural adequacy of the concrete spillway although no design computations were located. No data was acquired upon which to base an assessment with regards to the embankment composition or zoning.

b. Adequacy

Although the engineering data is regarded as sufficiently adequate, it is believed that further data relating to the earth embankment is required and such additional information should include embankment cross sections, borings and piezometer readings in selected localities.

c. Validity

The validity of the spillway data is not challenged as the inspection revealed it exists substantially as designed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspections were conducted on December 22, 1978 and January 10, 1979 and revealed the dam to be in a moderately satisfactory condition. The appended design plans were located at the Alloway Township Engineer's office.

b. Dam

The dam crest is at elevation 20 and although fairly level, contains numerous areas along the shoulder lines which have eroded away, especially around the larger tree root systems. The crest width north of the spillway is substantially wider than the 14 foot normal width to the south and rises 1 to 2 feet above the average elevation as it approaches the right abutment. The side slopes vary considerably from the design plan 2H:1V gradient and in numerous places on the downstream side, there are soft pockets and moss growing (evidence of seepage). Seepage was observed on the left slope of the 48" auxiliary gateway at the interface of the embankment and the natural clay stratum of the abutting original ground. There is some erosion on the slopes by the main spillway and the toe of slope at the right abutment wingwall is undermined. This quite possibly could be the result of turbulence in the outfall stilling basin (see Section 5). There is no visible riprap slope protection along the dam or little evidence of any attempts in recent years of reshaping any of the slopes. The entire embankment is heavily covered with secondary growth and there are numerous large, well-established trees growing on the downstream slopes.

c. Appurtenant Structures

The concrete spillway is 80 feet wide and the ogee crest is depressed 6" at the centerline. It appears to be in moderately good structural condition except both downstream wingwalls have sustained heavy structural cracks just below the ogee crest and have lost a considerable part of their structural stability as evidenced by relative movement between the spillway abutments and wingwalls. The steel sheeting on the downstream edge of the 30-foot apron slab appears in good alignment but the riprap originally placed in the downstream channel has long since washed out and the channel invert undercut to an appreciable degree. A considerable portion of the sheeting is exposed.

The auxiliary outlet with the 48-inch sluice gate has been additionally reinforced with steel sheeting driven along the downstream banks but the concrete slab cast between the sheeting is undermined. The steel access walk to the gate wheel is rusted but in a satisfactory structural condition. As with the main spillway channel, the auxiliary channel shows evidence of excessive outlet velocities over an extended period of time. The area of this sluiceway is where the 1950 washout occured.

d. Reservoir Area

The reservoir has a stable well-defined shoreline and is fairly clear of debris. It is fed by several streams with at least 3 smaller dams in the upland areas several miles upstream. There are numerous homes built along the south and east banks but most are 6 to 15 feet above normal pool. The sedimentation condition is unknown but appears to be quite heavy in several of the upper lagoons and along the face of the dam.

e. Downstream Channel

Below the main spillway, the constant overflow has eroded and caused substantial sweepout, resulting in a cavity which extends about 20 feet beyond each side of the wingwalls. There are several ill-defined channels below the dam; one at the old spillway and another, less apparent one below the old raceway at the left abutment. All merge before passing through the Greenwich Street bridge which is located 1000 feet downstream. This is a reinforced concrete County bridge (#1028) built in 1930 with a clear opening of about 50 feet and a headroom of about 10 feet. The houses immediately to the left on Fogg Landing Road are well above flood elevation but there is one dwelling right down on the stream bank that is just a few feet above the normal flowline. Below Greenwich Street, Alloway Creek widens out into marshy flatlands over 1000 feet wide. The downstream channel stilling basin immediately below the 48" auxiliary gateway is badly undercut and has exposed the structural end of the apron. The banks of both channels immediately below the dam are fairly clear of debris but have steep, almost vertical sides of the natural black stiff clays which appear to underlie the channel.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not observed by the inspection team and inasmuch as the reputed owners could not be located, little was learned regarding maintenance or operation.

4.2 MAINTENANCE OF DAM

There is no apparent recent maintenance undertaken at Alloway Dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

There is no day-to-day operation or flood control as the only operating facility is the 48-inch Armco sluice gate. The hardware appears in good condition and is well-greased but it is unknown when this was last operated or who retains possession of the gate wheel.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

No warning system exists except for monitoring by local police and CD personnel during heavy storms.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The present operational procedures and safeguards are deemed to be inadequate in view of the downstream hazards and performance record of the dam. As evidenced by the two previous failures, the present condition of the Alloway Lake Dam could be seriously exacerberated should any of the three upstream dams fail.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

In accordance with the criteria in the Recommended Guidelines for Safety Inspection, it has been determined that the dam at Alloway Lake is intermediate in size and is placed in the significant hazard category. Accordingly, the spillway design flood (SDF) was determined to be one-half the probable maximum flood (PMF). The inflow hydrograph was calculated using precipitation data from Hydrometeorological Report No. 33. In accordance with Corps of Engineers directives, the inflow hydrograph and flood routing were performed utilizing the HEC-1 computer program. Peak inflow to the reservoir for the ½ PMF was 9,829 cfs. When routed through the reservoir, this reduced insignificantly to 9,760 cfs. The main spillway and auxiliary gateway capacities before overtopping occurs are approximately 3,040 cfs. Based on this, the spillway will accommodate only 31% of the SDF. This flood would cause overtopping of the dam of slightly less than 2 feet.

b. Experience Data

There are no streamflow records available for Alloway Creek although a gaging station is purportedly located by the sluice gate at the right abutment. The most recent repair application (No. 455 dated March 1951) indicated an estimated 50-year flood flow of 2,235 cfs which was 120% of the Central Jersey value. The washout which occured in September 1950 did not overtop the dam but scoured out a portion of embankment over 60 feet wide and 16 feet deep. The break was attributed to a collapse of three older upstream dams which have since been rebuilt. There is a record of 10 inches of rainfall occuring 24 hours prior to this breaching.

c. Visual Observations

The spillway structures appear to function adequately but heavy flows are continually eroding the downstream channels due to the excessive exit energies. The existence of several shallow swales on the embankment backslopes and the unevenness of the crest presents a potentially dangerous condition should the dam again be overtopped.

d. Overtopping Potential

In view of the fact that in 1933, 1940 and 1950, the dam experienced complete washouts (although not necessarily overtopped), and that the design flood would surcharge the crest by approximately 2 feet, overtopping is viewed as potentially dangerous. Without knowledge of the embankment composition but in light of the fact that there have been three major washouts, it is apparent that the composition of the fill is quite susceptible to scouring should breaching occur.

e. Drawdown

The lake can be dewatered down to El. +5.0, (the invert of the 48-inch auxiliary sluiceway) in approximately 2.5 days. According to records, this is the approximate elevation of the lake bed.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

The four items of major concern to the inspection team were:

- The apparent susceptibility to complete washout should the embankment crest be overtopped,
- the continual scouring of the stilling basin immediately below the main spillway,
- the structural fracturing of the downstream wingwalls of the main spillway, and
- the presence of numerous large trees on the backslopes.

The overall condition and alignment of the dam are judged to be in a fair structural condition and the spillway is functioning satisfactorily. However, there is a serious concern should the crest be excessively overtopped. As previously stated, three earlier floods triggered complete washouts and indicate a lack of cohesive binder in the embankment composition. Further, from the lack of maintenance and large root systems prevalent on the backslope, shallow channels exist between the exposed roots which are potentially dangerous zones, especially should a large tree be blown over during a storm and its root system wrenched out of the ground. The large trees present an enigma; their removal would practically destroy the embankment structure and require extensive reconstruction; however, attempts to regrade the backslopes with additional cover would fairly quickly kill the larger specimens and the resulting decomposition of the root systems could eventually lead to piping problems.

The erosion of the downstream stilling basin below the main spillway is slowly undercutting the steel sheeting driven across the bottom of the ogee apron slab. The depth of this sheeting is unknown but roughly 9 to 12 feet is exposed. The spillway was originally designed to have the outlet invert at El. +9 (flush with the spillway apron), but this did not take into account the steep natural gradient of the channel immediately below the dam. The apparent sweepout of the channel bed may have commenced immediately after the 1933 construction, leaving the spillway apron in a perched condition. Additionally, the wingwalls along each side of the apron rely, in part, on the support of the apron for their stability (their width of footing is insufficient as a free-standing gravity retaining wall) and the bottom of footing (at El. +6.0) is completely exposed at the ends, being over 6 feet above the stilling basin elevation. Further, the timber sheeting cut-off under the walls is only 8 feet long. In summary, these wingwalls are in a somewhat precarious condition and have already cracked loose from their upper connection at the ogee spillway wall and the short cut-off wall that parallels the dam axis. Should the undercutting continue it is only a matter of time before they collapse.

b. Design and Construction Data

The review of the 1933 design plans concludes that the design was properly executed and except for the sweep-out of the downstream channel, is thought to be structurally acceptable. However, in view of its present condition and the hydraulic head resulting from the design flood presented in Section 5, its long-term structural reliability is moot. Nothing is known regarding the construction except that the workmanship in the main spillway appears to be of an excellent quality, considering its age. The auxiliary gateway construction at the right abutment is in a far more deteriorated condition, especially at the undermined outlet slab.

c. Operating Records

See Section 4. According to local residents, the dam has operated satisfactorily since its breaching in 1950. However, there are no records available to substantiate this information and nothing is known of a 1940 failure which was repaired by the owner without State permit or approval.

d. Post Construction Changes

There are no records of any structural modifications or renovations since the installation of the auxiliary gateway in 1951-2. Subsequent to that work, steel sheeting was installed in the downstream channel and the concrete apron extended. Additionally (as previously stated), the steel sheet-piling was driven across the end of the main spillway apron at a slightly later date.

e. Seismic Stability

Alloway Lake Dam is located in Zone 1 and due to its geometry and size, has negligible potential vulnerability to earthquake forces. Experience indicates dams in Zone 1 will have adequate stability under dynamic loading conditions if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the visual inspection procedures stipulated by the Corps of Engineers, the Alloway Lake Dam appears to be in a fair overall condition for normally expected flood conditions although the spillway is incapable of passing the design flood. The dam embankment is built of unknown construction material and some seepage was observed. Overtopping of the dam crest could erode the steep wooded backslopes and possibly breach the dam. Serious detrimental conditions were observed at the spillway to render a structurally inadequate assessment and the long-term stability remains extremely questionable until the remedial measures set forth hereinafter are completed.

The hydraulic capacity of the spillway is assessed as inadequate as it has been determined that the embankment would be overtopped for all storms exceeding 31% of the PMF. It is calculated that the design flood would overtop the embankment by approximately two feet and it is questionable whether the dam could withstand this hydraulic surcharge.

b. Adequacy of Information

Except for visual observations and the review of the 1933 construction plans, little information was otherwise available as no original data exists regarding the composition of the embankment. No recent surveys or inspections have been made and performance data is believed to be nonexistent. The availability of information is therefore deemed to be inadequate.

c. Urgency

Further investigation should be undertaken in the near future as a collapse of this

dam could irreparably damage the downstream bridge and endanger the private residence in the flood zone.

d. Necessity for Further Study

Because the structural stability cannot reasonably be established with any reliance, the obtaining of additional information and the undertaking of further studies is recommended.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

It is recommended that additional engineering studies be initiated in the near future as the dam is classified in the significant hazard category and its spillway capacity is inadequate. It is recommended that the owner provide stability computations and additional data on the composition of the embankment. This information is considered essential to completely assess the continued stability as the structural condition is classified as questionable.

a. Recommendations

It is recommended that the following repairs be undertaken very soon:

1) The downstream channel immediately below the main spillway be filled with stone or riprap up to a design grade to prevent further undercutting of the concrete spillway apron. Consideration could be given to driving additional sheeting parallel and downstream of the spillway wingwalls and backfilling behind the added sheeting.

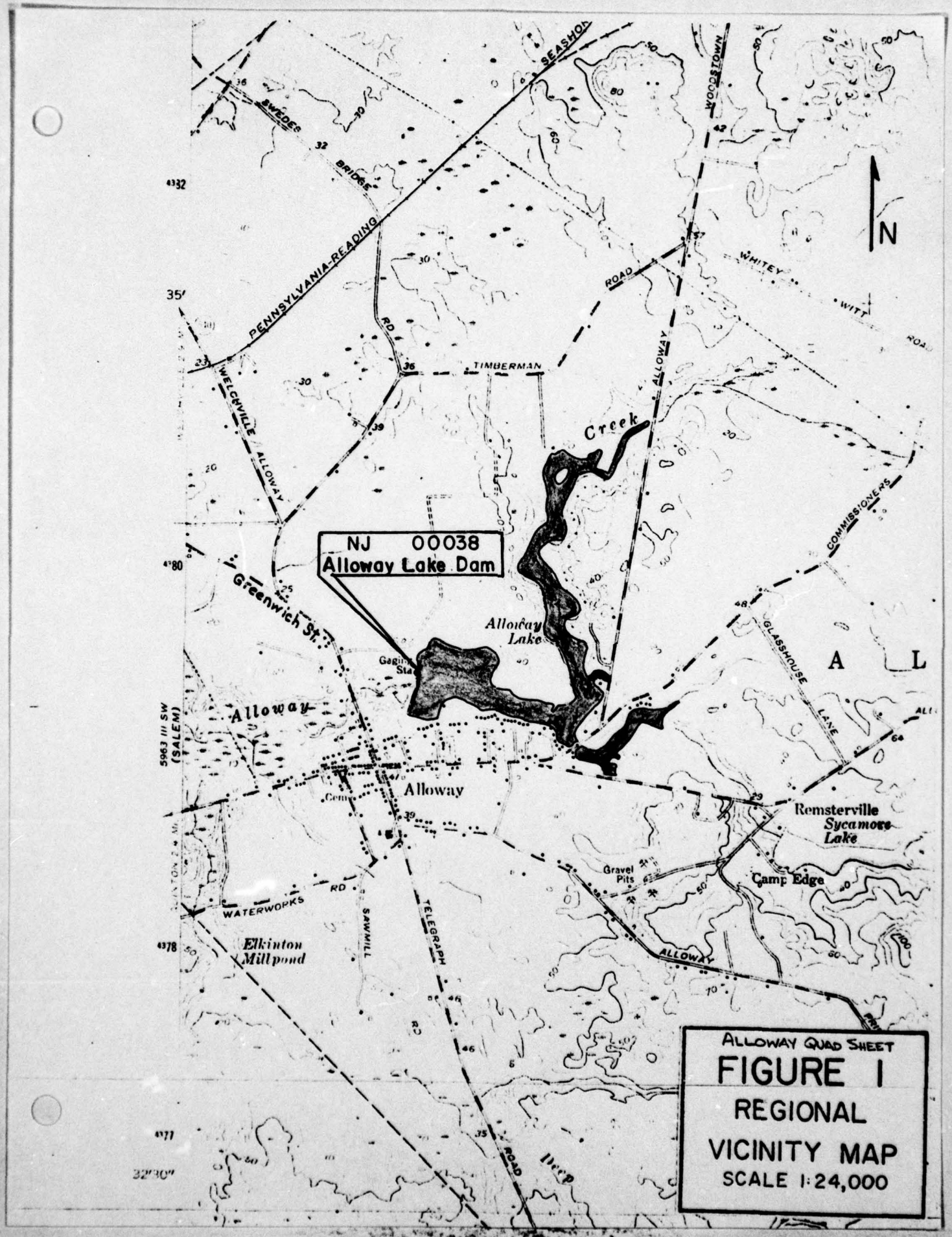
2) The apron slab at the auxiliary gate outlet should be backfilled and channel protection dumped in the stream bed.

3) The dam crest should be regraded and brought up to a uniform elevation and the major swales cut into the backslope filled and regraded.

In the future, consideration could be given to installing an auxiliary spillway adjacent to the main spillway and raising the remainder of the dam crest to a higher elevation. All tree growth and root systems should eventually be removed and the dam backslope regraded and protected.

b. O&M Maintenance and Procedures

Inasmuch as the dam is owned by private interests who apparently do not reside in the immediate area, the local police and Civil Defense authorities should develop definitive plans for monitoring the dam during periods of heavy flows and develop a procedure for alerting the homes immediately downstream in the event of potential floods. The owners should develop a checklist for periodic maintenance inspections so a record of conditions and repairs can be maintained.



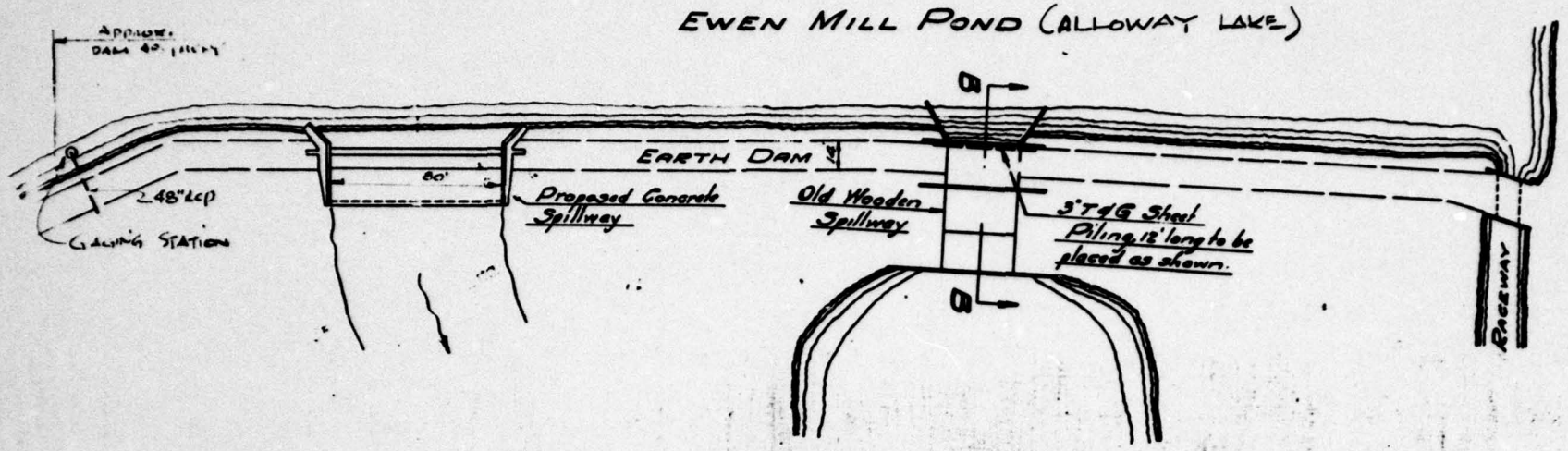
ALLOWAY QUAD SHEET

FIGURE 1

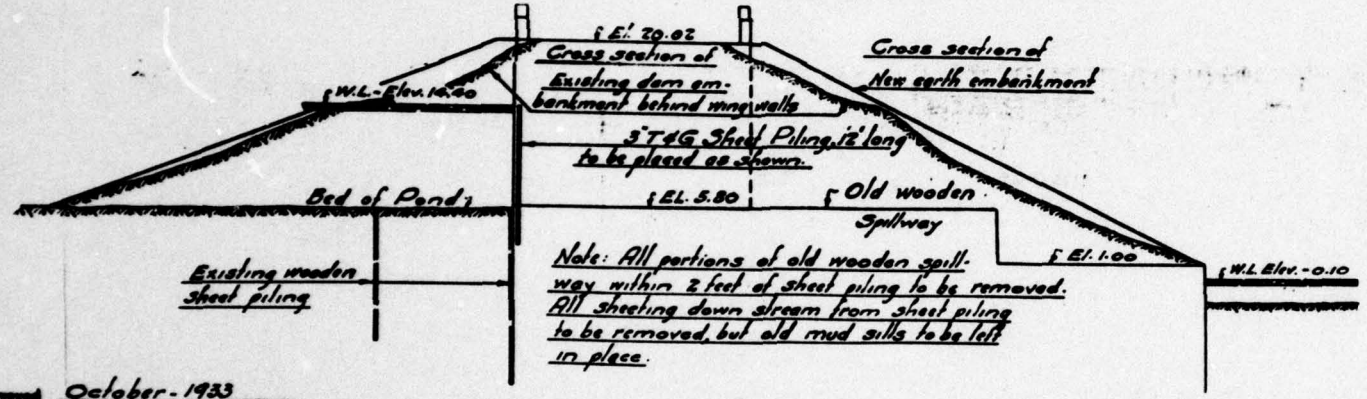
REGIONAL VICINITY MAP

SCALE 1:24,000

EWEN MILL POND (ALLOWAY LAKE)



LOCATION PLAN
Scale - 1" = 50'



SECTION B-B
Scale - 1" = 10'

Surveyed October - 1933
By Harry H. Stevens
Municipal Engineer & Land Surveyor
License No. 5535
Approved in Accordance with Chapter 214, P. L. 1921, as Amended.
Civil Engineer & Land Surveyor. License No. 681
James A. Lefferts

FIG. 2

PROPOSED MILL POND SPILLWAY FOR EWAN MILLING COMPANY
ALLOWAY. N. J. OCTOBER 1933

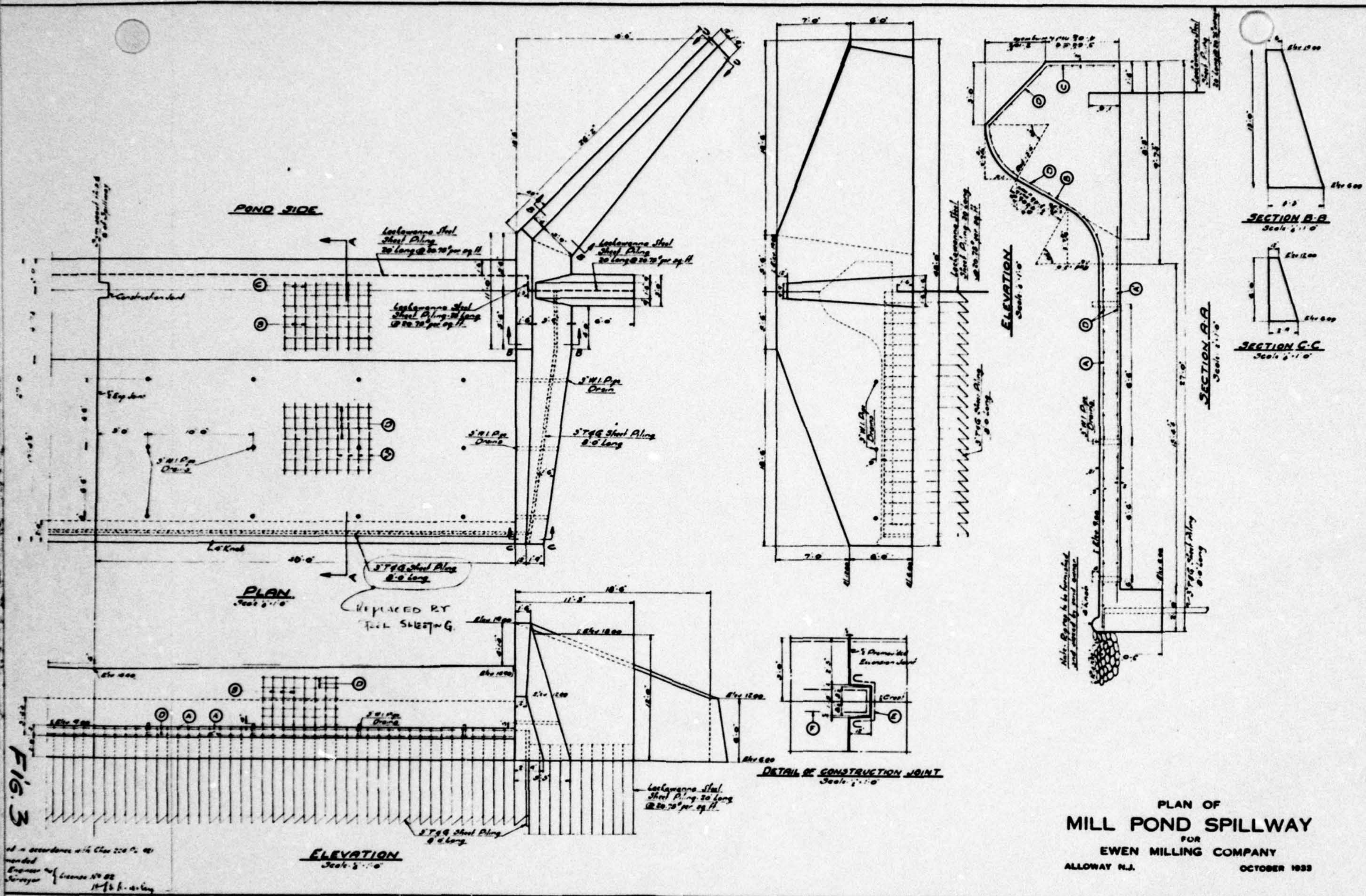


FIG. 3

PLAN OF
MILL POND SPILLWAY
FOR
EWEN MILLING COMPANY
ALLOWAY N.J. OCTOBER 1933

BY DL DATE 4-79
CHKD. BY DATE
SUBJECT

LOUIS BERGER & ASSOCIATES INC.

Alloway Lake Dam

SHEET NO. OF
PROJECT C226

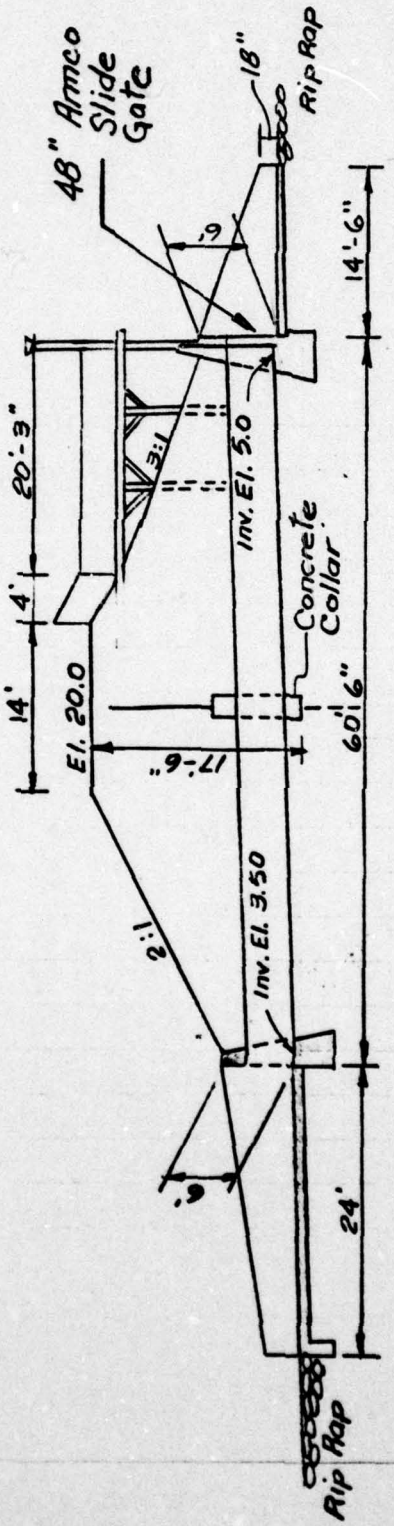


Figure 4

Check List
Visual Inspection
Phase 1

Name Dam Alloway Lake County Salem State New Jersey Coordinators NJDEP

Date(s) Inspection Dec. 22, 1978
Jan. 10, 1979 Weather Cold Temperature 20°

Pool Elevation at Time of Inspection 15.0 M.S.L. Tailwater at Time of Inspection + 7.5 M.S.L.

Inspection Personnel:

K. Jolls

R. Lang

E. Simone

K. Jolls Recorder

Dam No. 00038

CONCRETE/MASONRY DAMS
(Main Spillway)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Good condition except major cracks in wingwalls (see photographs). Lower ends of wings exposed and footings undercut (serious condition).	Minor bank erosion behind both wingwalls.
DRAINS	None except weepholes in wingwalls (deep).	
WATER PASSAGES	None except spillway.	Old abandoned channel.
FOUNDATION	Satisfactory (no differential settlement or tilting noted) except wingwalls at lower end in danger of collapse.	Spillway founded on steel sheeting (unfamiliar size).

CONCRETE/MASONRY DAMS
(Main Spillway)

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Minor, concrete surfaces in good condition.	Except single major structural crack at upper end of each wingwall.
STRUCTURAL CRACKING	Yes - at wingwalls major breaks extend right thru downstream walls.	
VERTICAL AND HORIZONTAL ALIGNMENT	Satisfactory	Downstream sheeting exposed 6'-8' in pool below ogee spillway.
MONOLITH JOINTS	None	
CONSTRUCTION JOINTS	None	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None (embankment surface frozen).	Right abutment at gage station located 125' from north abutment of spillway.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None. Right embankment width = 25'±. Height back of spillway 10-12'. Left embankment straight and narrower (14'±).	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Some on downstream side. Large trees and secondary growth.	Exposed root systems at larger trees.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Satisfactory - excellent condition. Little evidence of old spillway structure 200' south of existing spillway.	
RIPRAP FAILURES	No riprap.	Note: Spillway comments continued on "Outlet Works".

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory.	Abutments (limits of fill) merge very gradually at ends of dam.
ANY NOTICEABLE SEEPAGE	Yes (ground frozen). Worst area to right of auxiliary spillway and natural bank (clay).	Several old channels below gaging station and two mill channels near left abutment.
STAFF GAGE AND RECORDER	Gaging station at right abutment. (no records indicated in USGS Books).	Controls in good condition. Well-greased.
DRAINS		

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Satisfactory.	
INTAKE STRUCTURE	Broad crested weir - concrete. (no controls)	Wide = 80'. (6" depression at center).
OUTLET STRUCTURE	None	
OUTLET CHANNEL	At gaging station. Outlet steel sheeting 12' wide. Older channels merge into main stream immediately downstream.	Depth of invert unknown. (Outfall invert roughly at downstream elevation).
EMERGENCY GATE	Gaging station sluiceway at north abutment.	48" Sluicegate - good condition. Could be used in emergency.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	See previous page.	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Natural channel	Deeply scoured out just below apron. Steel sheeting exposed (length unknown).
BRIDGE AND PIERS	None at dam	Bridge downstream at Greenwich Street (1000'±).

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	None	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	None	
BRIDGE AND PIERS	None	
GATES AND OPERATION EQUIPMENT	None	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Staff gage recorder (see previous page).	Additional gage noted downstream about 50' below Greenwich Street bridge.
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	Additional gage below Greenwich Street (water quality).

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Both steep and gentle areas. Several summer cabins right down at waters edge.	Lake formally called Ewen Pond (circa 1933)
SEDIMENTATION	Unknown Bottom depth at dam Elevation +9±.	Partially frozen (could not observe much).

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Good natural channel. Banks eroding continually. Timber and fallen debris in channel.	Bad scour immediately below spillway apron (should be filled with riprap).
SLOPES	Steel (almost vertical - 4'-5'± in height).	Appear to be continually eroding.
APPROXIMATE NO. OF HOMES AND POPULATION	1 home just south of bridge that is down on stream bank (about 5' above normal flood level). All homes along Fogglanding Road well above flood elevation.	
DOWNSTREAM BRIDGE	Bridge downstream at Greenwich Street built 1930 Salem County #Bridge 1028. Bridge has 3-20' spans and about 10' clear headroom. Top estimated to be elev. + 16±.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available (Town Engineer's Office)*
REGIONAL VICINITY MAP	Available (Quad Sheet)
CONSTRUCTION HISTORY	Parts available (Heresay information & N.J.D.E.P. records)
TYPICAL SECTIONS OF DAM	Available (of spillway only)*
HYDROLOGIC/HYDRAULIC DATA	None available
OUTLETS - PLAN	Available *
- DETAILS	Available
-CONSTRAINTS	Not available
-DISCHARGE RATINGS	Available
RAINFALL/RESERVOIR RECORDS	None available

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS	Some available (NJDEP)
HYDROLOGY & HYDRAULICS	Some available
DAM STABILITY	Not available
SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS	Available
BORING RECORDS	Not available
LABORATORY	Not available
FIELD	Available
POST-CONSTRUCTION SURVEYS OF DAM	Not available
BORROW SOURCES	Not available

ITEM	REMARKS
MONITORING SYSTEMS	Unknown
MODIFICATIONS	Unknown
HIGH POOL RECORDS	Unknown
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Known (NJDEP)
MAINTENANCE OPERATION RECORDS	Not available

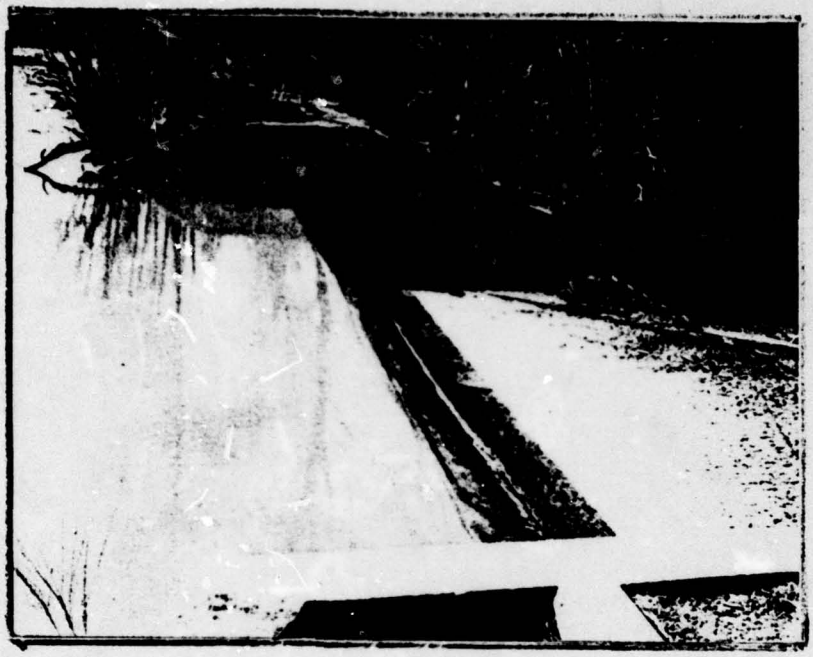
ITEM	REMARKS
SPILLWAY PLAN	Available *
SECTIONS	Available *
DETAILS	Available *
OPERATING EQUIPMENT PLANS & DETAILS	Available *

View South at spillway

January 1979

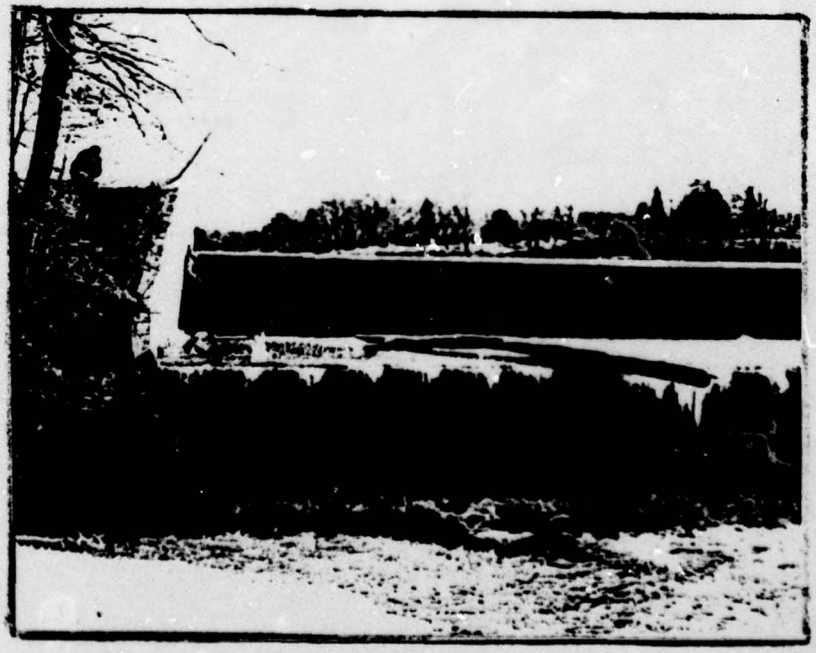
End of spillway slab

January 1979



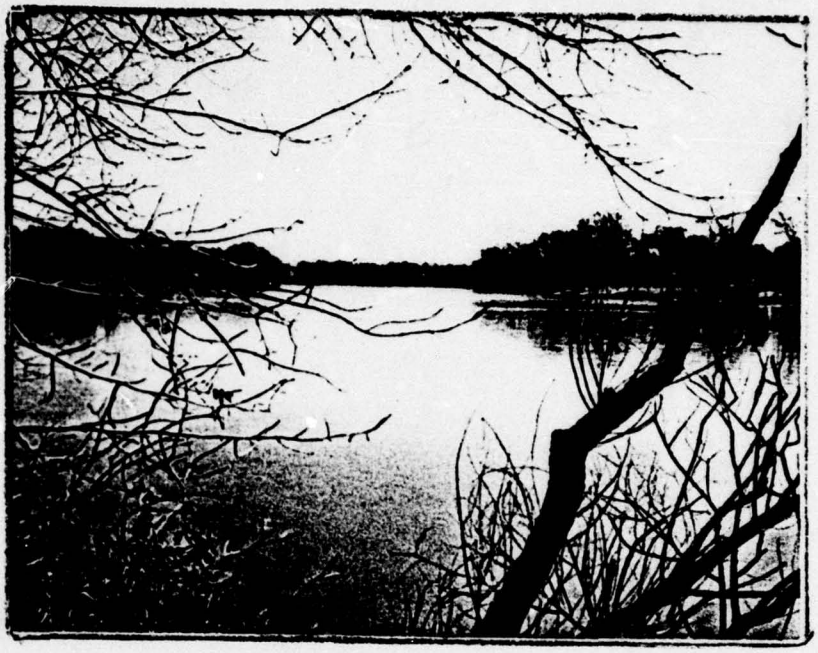
Spillway

January 1979



Spillway (north end)

January 1979

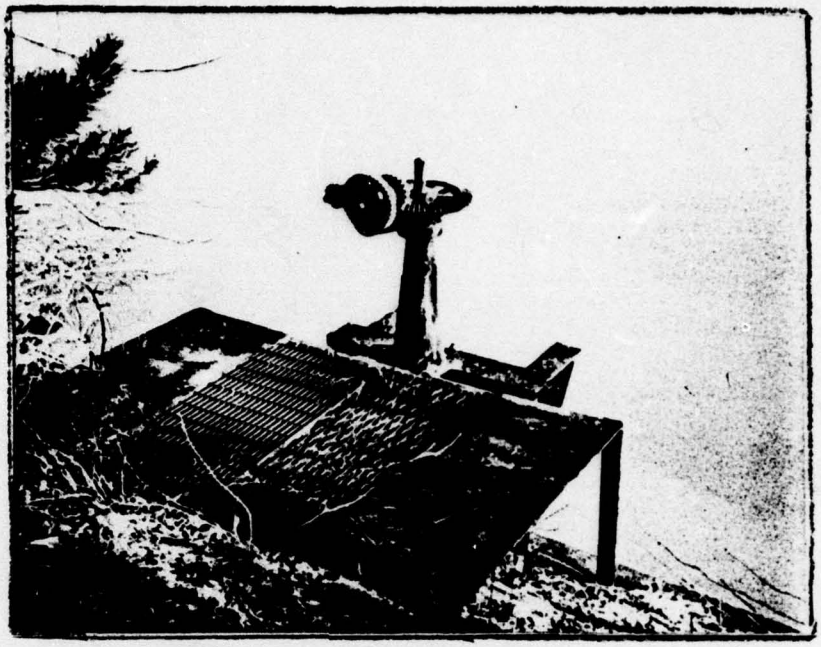


Alloway Lake

January 1979

Downstream channel

January 1979



48"Ø vertical lift sluicegate

January 1979

Downstream channel below sluicegate

January 1979

Dam No. 00038

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Drainage Area = 21.9 sq.mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): + 14.40 M.S.L. (490 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): + 20.0 M.S.L. (1340 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: + 19.0 M.S.L. (Dam Application 455)

ELEVATION TOP DAM: + 20.0 M.S.L.

CREST:

a. Elevation + 14.40 M.S.L.
b. Type Concrete ogee crest weir
c. Width 1.0' ±
d. Length 80'
e. Location Spillover 125' from right abutment
f. Number and Type of Gates None

OUTLET WORKS: 1-48" ø Armco Slide gate

a. Type Vertical lift, hand-operated gate
b. Location At right abutment
c. Entrance inverts + 5.0 M.S.L.
d. Exit inverts + 3.5 M.S.L.
e. Emergency draindown facilities None

HYDROMETEOROLOGICAL GAGES:

a. Type Staff gage
b. Location Right abutment at slide gate
c. Records None (ownership unknown)

MAXIMUM NON-DAMAGING DISCHARGE: 3040+ cfs

BY D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A1 OF ...
CHKD. BY ..... DATE ..... ALLOWAY LAKE DAM INSPECTION PROJECT C226
SUBJECT .....

SNYDER COEFFICIENTS (OBTAINED FROM CORPS)

$C_t = 4.51$

$C_p = 0.70$

Drainage Area = 21.9 sq. miles

Length of longest watercourse = 6.42 miles

Length along watercourse to point perpendicular to C.G = 2.60 miles

$\therefore T_p = C_t (LL_c)^{0.3} = 4.51 (6.42 \times 2.6)^{0.3}$

$= 10.49$ hours

PRECIPITATION

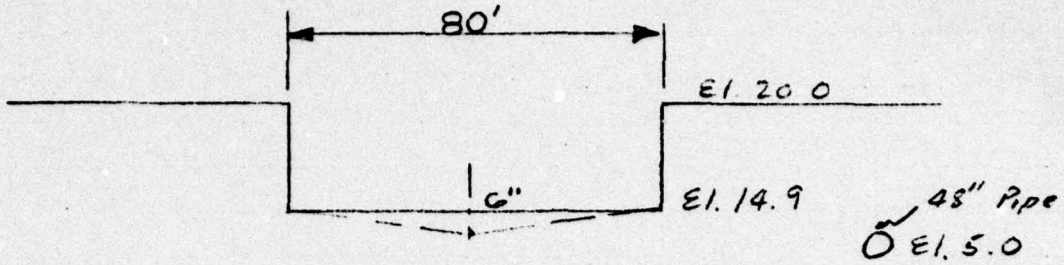
PMF for 200 square miles & 24 hours duration = 24"

Maximum 6 hour percentage = 105 %

Maximum 12 hour percentage = 115 %

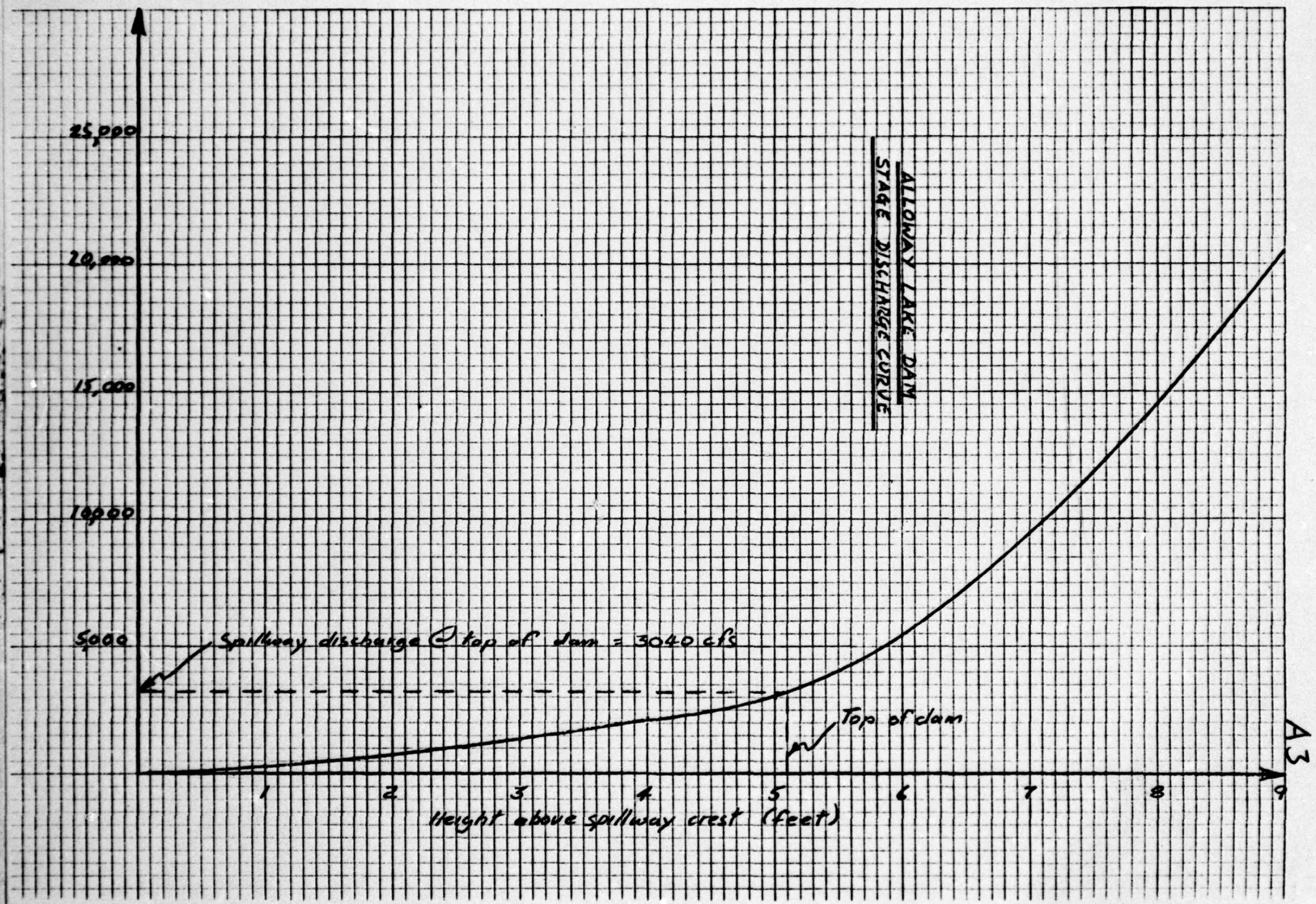
Maximum 24 hour percentage = 124 %

BY D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A2 OF
CHKD. BY DATE ALLOWAY LAKE DAM INSPECTION PROJECT C226
SUBJECT



	Over Spillway L = 80'		Over Dam L = 620'			48" Pipe $Q = Ca\sqrt{2gH}$ C=.58		ΣQ
H	C	Q	H	C	Q	H	Q	
1	3.3	264				10.9	193	264
2	3.3	747				11.9	202	747
3	3.3	1372				12.9	210	1372
4	3.3	2112				13.9	218	2112
5	3.3	2952				14.9	226	2952
6	3.3	3880	0.9	2.8	1482	15.9 C=0.6	241	5362
7	3.3	4889	1.9	2.8	4547	16.9	249	9436
8	3.3	5974	2.9	2.8	8573	17.9	256	14547
9	3.3	7128	3.9	2.8	13370	18.9	263	20498
10	3.3	8348	4.9	2.8	18830	19.9	270	27178

ΣQ does not include discharge through 48" pipe



A3

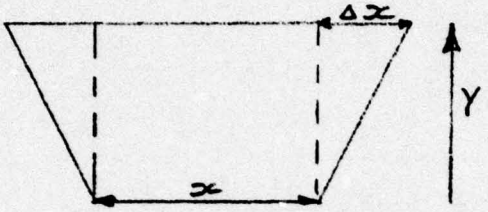
BY D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A4 OF...

CHKD. BY..... DATE..... ALLOWAY LAKE DAM INSPECTION PROJECT C226

SUBJECT SURCHARGE STORAGE

Area of Lake @ El 14.9 ≈ 107.6

Area of Contour @ El. 20.0 ≈ 225.7



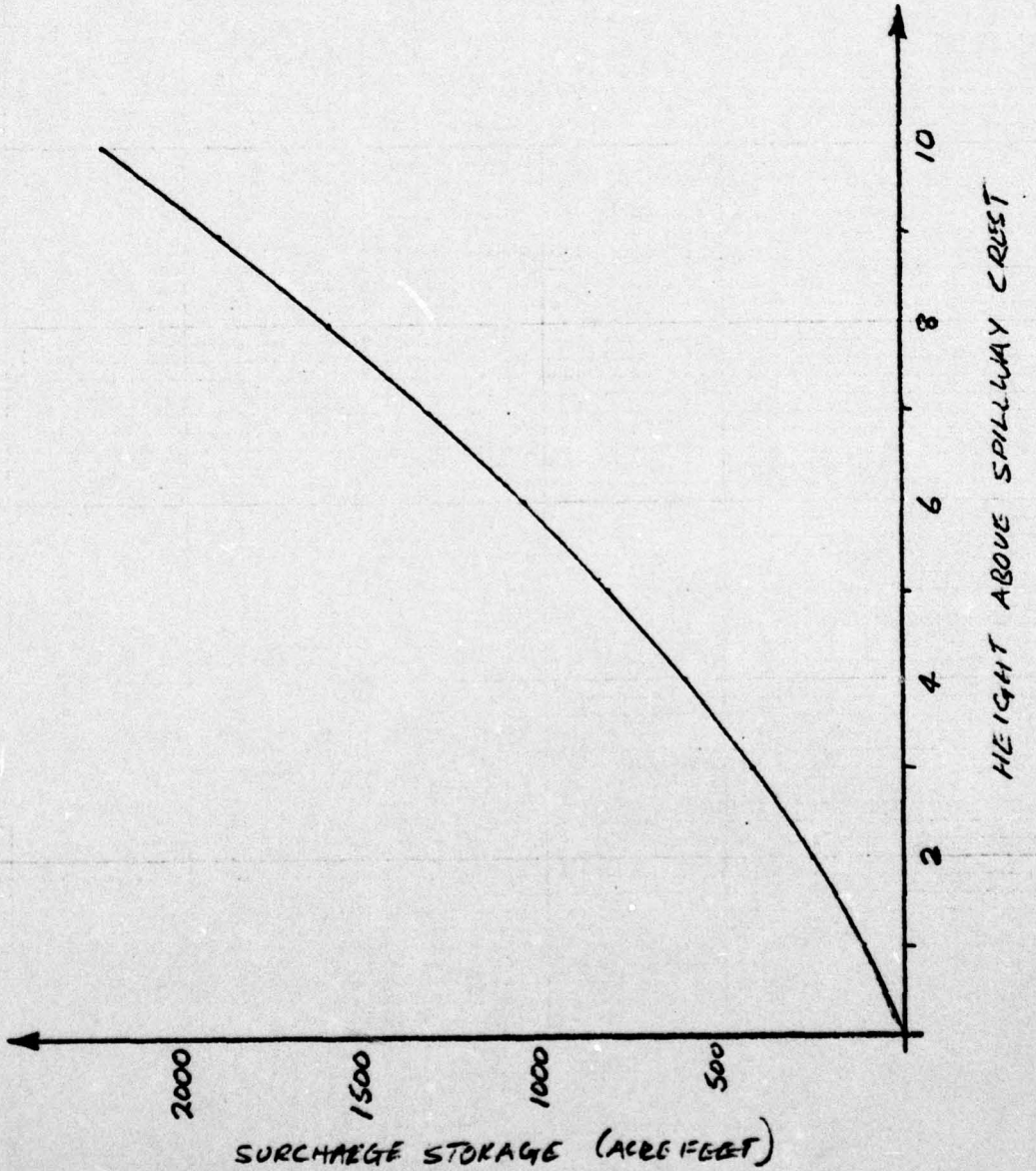
Increment in volume = $(x+\Delta x)y$

HEIGHT ABOVE Spillway (feet)	STORAGE (Acre feet)
1	119
2	262
3	427
4	616
5	827
6	1062
7	1321
8	1602
9	1906
10	2234

BY D. J. M DATE 1-79
CHKD. BY ..... DATE .....

SUBJECT STAGE STORAGE CURVE
ALLOWAY LAKE DAM INSPECTION

SHEET NO. A5 OF .....
JOB NO. C226



BY D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A6 OF

CHKD. BY DATE ALLOWAY LAKE DAM INSPECTION PROJECT C226

SUBJECT APPROXIMATE DRAWDOWN CALCULATIONS

AREA OF LAKE = 107.6 ACRES @ El. 14.9

Invert of pipe @ El. 50

$\Delta H = 9.9 \approx 10$

Drawdown in 2 stages

Stage 1

$$\text{Volume} = \frac{490 \times 43560}{2} \text{ ft}^3$$

head = 7.5'

Discharge = 138 cfs

$$\text{Time} = \frac{490 \times 43560}{2 \times 138 \times 3600}$$

$= 21.5$ hours

Stage 2

Volume as above

head = 2.5'

Discharge = 80 cfs

time = 37 hours

Σ time = $37 + 21.5 \approx 59$ hours

$= 2.4$ days

Say 2.5 days

BY DJM DATE 4-79 LOUIS BERGER & ASSOCIATES INC. SHEET NO. A7 OF
CHKD. BY DATE Alloway Lake Dam Inspect PROJECT C226
SUBJECT HEC-1

ALLOWAY LAKE DAM INSPECTION SOUTH GROUP C226
BY D.J.MULLIGAN
JANUARY 1979

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	1	0	0	0	0	0	0	0	0

JOPER	NWT
5	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1
RTIOS= 1.00 0.50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
14	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	21.90	0.0	21.90	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	24.00	105.00	115.00	124.00	0.0	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.826

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

UNIT HYDROGRAPH DATA
TP= 10.49 CP=0.70 NTA= 0

RECESSION DATA
STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=12.24 AND R= 7.66 INTERVALS

UNIT HYDROGRAPH 48 END-OF-PERIOD ORDINATES, LAG= 10.44 HOURS, CP= 0.70 VOL= 1.00

29.	106.	213.	335.	465.	599.	729.	835.	909.	952.
962.	937.	862.	759.	666.	585.	513.	450.	395.	346.
304.	267.	234.	205.	180.	158.	139.	122.	107.	94.
82.	72.	63.	55.	49.	43.	37.	33.	29.	25.
22.	19.	17.	15.	13.	12.	10.	9.		

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.12	0.00	0.

LOUIS BERGER & ASSOCIATES INC.

Alloway Lake Dam Inspect.

2	0.12	0.00	0.
3	0.12	0.00	0.
4	0.12	0.00	0.
5	0.12	0.02	0.
6	0.12	0.02	2.
7	0.33	0.23	12.
8	0.33	0.23	40.
9	0.33	0.23	93.
10	0.33	0.23	175.
11	0.33	0.23	286.
12	0.33	0.23	429.
13	2.08	1.98	650.
14	2.50	2.40	1042.
15	3.12	3.02	1687.
16	7.91	7.81	2783.
17	2.91	2.81	4454.
18	2.29	2.19	6590.
19	0.18	0.08	9013.
20	0.18	0.08	11521.
21	0.18	0.08	13956.
22	0.18	0.08	16154.
23	0.18	0.08	17922.
24	0.18	0.08	19119.
25	0.0	0.0	19659.
26	0.0	0.0	19524.
27	0.0	0.0	18762.
28	0.0	0.0	17406.
29	0.0	0.0	15695.
30	0.0	0.0	13942.
31	0.0	0.0	12301.
32	0.0	0.0	10839.
33	0.0	0.0	9543.
34	0.0	0.0	8393.
35	0.0	0.0	7375.
36	0.0	0.0	6474.
37	0.0	0.0	5680.
38	0.0	0.0	4984.
39	0.0	0.0	4373.
40	0.0	0.0	3837.
41	0.0	0.0	3366.
42	0.0	0.0	2953.
43	0.0	0.0	2591.
44	0.0	0.0	2273.
45	0.0	0.0	1995.
46	0.0	0.0	1750.
47	0.0	0.0	1535.
48	0.0	0.0	1347.
49	0.0	0.0	1182.
50	0.0	0.0	1037.
51	0.0	0.0	910.
52	0.0	0.0	798.
53	0.0	0.0	700.
54	0.0	0.0	614.
55	0.0	0.0	537.
56	0.0	0.0	470.
57	0.0	0.0	410.
58	0.0	0.0	358.
59	0.0	0.0	312.
60	0.0	0.0	272.
61	0.0	0.0	223.
62	0.0	0.0	177.
63	0.0	0.0	132.
64	0.0	0.0	55.
65	0.0	0.0	26.
66	0.0	0.0	6.
67	0.0	0.0	5.
68	0.0	0.0	3.
69	0.0	0.0	2.
70	0.0	0.0	1.
71	0.0	0.0	1.
72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.
89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
101	0.0	0.0	0.
102	0.0	0.0	0.
103	0.0	0.0	0.
104	0.0	0.0	0.
105	0.0	0.0	0.
106	0.0	0.0	0.
107	0.0	0.0	0.
108	0.0	0.0	0.
109	0.0	0.0	0.
110	0.0	0.0	0.
111	0.0	0.0	0.
112	0.0	0.0	0.
113	0.0	0.0	0.
114	0.0	0.0	0.
115	0.0	0.0	0.
116	0.0	0.0	0.
117	0.0	0.0	0.
118	0.0	0.0	0.
119	0.0	0.0	0.
120	0.0	0.0	0.
121	0.0	0.0	0.
122	0.0	0.0	0.
123	0.0	0.0	0.

124	0.0	0.0	0.
125	0.0	0.0	0.
126	0.0	0.0	0.
127	0.0	0.0	0.
128	0.0	0.0	0.
129	0.0	0.0	0.
130	0.0	0.0	0.
131	0.0	0.0	0.
132	0.0	0.0	0.
133	0.0	0.0	0.
134	0.0	0.0	0.
135	0.0	0.0	0.
136	0.0	0.0	0.
137	0.0	0.0	0.
138	0.0	0.0	0.
139	0.0	0.0	0.
140	0.0	0.0	0.
141	0.0	0.0	0.
142	0.0	0.0	0.
143	0.0	0.0	0.
144	0.0	0.0	0.
145	0.0	0.0	0.
146	0.0	0.0	0.
147	0.0	0.0	0.
148	0.0	0.0	0.
149	0.0	0.0	0.
150	0.0	0.0	0.
SUM	24.59	22.11	310756.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	19659.	18732.	11563.	4316.	310757.
INCHES		7.96	19.65	22.00	22.00
AC-FT		9293.	22947.	25696.	25696.

HYDROGRAPH AT STA 14 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	2.	12.	40.	93.	175.
286.	429.	650.	1042.	1687.	2783.	4454.	6590.	9013.	11521.
13956.	16154.	17922.	19119.	19659.	19524.	18762.	17406.	15695.	13942.
12301.	10839.	9543.	8393.	7375.	6474.	5680.	4984.	4373.	3837.
3366.	2953.	2591.	2273.	1995.	1750.	1535.	1347.	1182.	1037.
910.	798.	700.	614.	537.	470.	410.	358.	312.	272.
223.	177.	132.	55.	26.	6.	5.	3.	2.	1.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	19659.	18732.	11563.	4316.	310757.
INCHES		7.96	19.65	22.00	22.00
AC-FT		9293.	22947.	25696.	25696.

HYDROGRAPH AT STA 14 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	1.	6.	20.	47.	87.
143.	214.	325.	521.	843.	1392.	2227.	3295.	4506.	5761.
6978.	8077.	8961.	9559.	9829.	9762.	9381.	8703.	7848.	6971.

6151.	5420.	4771.	4197.	3687.	3237.	2840.	2492.	2186.	1918.
1683.	1477.	1296.	1137.	997.	875.	768.	674.	591.	519.
455.	399.	350.	307.	269.	235.	205.	179.	156.	136.
112.	89.	66.	27.	13.	3.	2.	2.	1.	1.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9829.	9366.	5782.	2158.	155378.
INCHES		3.98	9.82	11.00	11.00
AC-FT		4647.	11473.	12848.	12848.

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
114	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	262.	427.	616.	827.	1062.	1321.	1602.	1906.	2234.
OUTFLOW=	0.	747.	1372.	2112.	2952.	5362.	9436.	14547.	20498.	27178.

STATION 114, PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	2.	7.	19.	44.
83.	141.	225.	356.	568.	969.	1695.	2770.	5629.	9283.
12235.	14659.	16786.	18337.	19278.	19558.	19187.	18201.	16725.	15020.
13372.	11826.	10423.	9196.	8162.	7187.	6313.	5540.	4984.	4460.
3949.	3479.	3058.	2826.	2630.	2416.	2198.	1986.	1785.	1597.
1423.	1268.	1127.	1000.	885.	782.	702.	635.	572.	513.
457.	403.	351.	296.	242.	195.	155.	123.	98.	78.
61.	49.	38.	30.	24.	19.	15.	12.	9.	7.
6.	5.	4.	3.	2.	2.	1.	1.	1.	1.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	0.	1.	2.	7.	15.
29.	49.	79.	125.	199.	321.	509.	781.	1079.	1311.
1475.	1608.	1716.	1796.	1844.	1858.	1839.	1789.	1713.	1626.
1537.	1452.	1375.	1306.	1240.	1178.	1122.	1073.	1025.	974.
924.	878.	837.	795.	746.	692.	638.	584.	532.	484.
440.	399.	362.	329.	299.	271.	246.	223.	201.	180.

BY DJM DATE 4-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A 11 OF
CHKD. BY DATE Alloway Lake Dam Inspect PROJECT C216
SUBJECT HEC-1

160.	141.	123.	104.	85.	68.	54.	43.	34.	27.
22.	17.	13.	11.	8.	7.	5.	4.	3.	3.
2.	2.	1.	1.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	19558.	18558.	11408.	4316.	310756.
INCHES		7.88	19.38	22.00	22.00
AC-FT		9207.	22639.	25693.	25696.

STATION 114, PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	1.	3.	10.	22.
42.	70.	112.	178.	284.	460.	744.	1289.	2014.	2894.
4899.	6820.	8158.	9026.	9563.	9763.	9599.	9147.	8460.	7632.
6788.	5998.	5305.	4816.	4296.	3800.	3347.	2947.	2775.	2571.
2353.	2135.	1926.	1728.	1544.	1375.	1225.	1088.	965.	854.
755.	684.	619.	558.	501.	448.	400.	356.	316.	281.
248.	216.	187.	158.	129.	103.	82.	65.	52.	41.
32.	26.	20.	16.	13.	10.	8.	6.	5.	4.
3.	2.	2.	1.	1.	1.	1.	1.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	0.	0.	1.	3.	8.
15.	25.	39.	62.	100.	161.	261.	405.	591.	812.
1017.	1155.	1240.	1295.	1328.	1339.	1330.	1303.	1259.	1206.
1153.	1102.	1056.	1009.	958.	910.	865.	826.	783.	731.
677.	622.	568.	518.	471.	428.	388.	352.	320.	290.
264.	240.	217.	196.	176.	157.	140.	125.	111.	98.
87.	76.	66.	55.	45.	36.	29.	23.	18.	14.
11.	9.	7.	6.	4.	3.	3.	2.	2.	1.
1.	1.	1.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9763.	9260.	5629.	2158.	155376.
INCHES		3.93	9.56	11.00	11.00
AC-FT		4594.	11172.	12846.	12848.

BY DJM DATE 4-79
CHKD. BY ____ DATE ____
SUBJECT ____

LOUIS BERGER & ASSOCIATES INC.

Alloway Lake Dam Insp.

HEC-1

SHEET NO. A12 OF ____
PROJECT C2246

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS	
OPERATION	STATION	PLAN	1.00	0.50
HYDROGRAPH AT	14	1	19659.	9829.
		2	5034.	3643.
ROUTED TO	114	1	19558.	9763.
		2	5034.	3643.